Ethernet as a network topology

Technology, Computer

Ethernet is the most widely used network topology. You can choose between bus and star topologies, and coaxial, twisted-pair, or fiber optic cabling. But with the right connective equipment, multiple Ethernet-based LANs (local area networks) can be linked together no matter which topology and/or cabling system they use. In fact, with the right equipment and software, even Token Ring, Apple Talk, and wireless LANs can be connected to Ethernet.

The access method Ethernet uses is CSMA/CD (Carrier Sense Multiple Access with Collision Detection). In this method, multiple workstation access a transmission medium (Multiple Access) by listening until no signals are detected (Carrier Sense). Then they transmit and check to see if more than one signal is present (Collision Detection). Each station attempts to transmit when it " believes" the network is free. If there is a collision, each station attempts to retransmit after a preset delay, which is different for each workstation.

Collision detection is an essential part of the CSMA/CD access method. Each transmitting workstation needs to be able to detect that simultaneous (and therefore data-corrupting) transmission has taken place. If a collision is detected, a " jam" signal is propagated to all nodes. Each station that detects the Collision will wait some period of time and then try again.

The two possible topologies for Ethernet are bus and star. The bus is the simplest (and the traditional) topology. Standard Ethernet (10BASE5) and Thin Ethernet (1OBASE2), both based on coaxial cable systems, use the bus.

Twisted-Pair Ethernet (10BASE-T), based on unshielded twisted pair, and Fiberoptic Ethernet (FOIRL and 10BASE-FL), based on fiberoptic cable, use the star.

In the following document we will try to explain what switched, Fast and Gigabit Ethernet are and make comparison of these three.

LAN segments can be interconnected using bridges or routers. This works well when the traffic between segments is not high, but the interconnecting devices can become bottlenecks as the inter-segment traffic increases. Until recently, there were few ways to alleviate this problem.

Now, however, a new class of interconnect products has emerged that can boost bandwidth on overburdened, traditional LANs while working with conventional cabling and adapters. These are known as LAN switches and are available for Ethernet, token ring, and FDDI.

Switchingtechnologyis increasing the efficiency and speed of networks. This technology is making current systems more powerful, while at the same time facilitating the migration to faster networks. Understanding this technology is important; only then can we design and implement switched networks from the ground up.

Switching directs network traffic in a very efficient manner - it sends information directly from the port of origin to only its destination port. Switching increases network performance, enhances flexibility and eases moves, adds and changes. Switching establishes a direct line ofcommunicationbetween two ports and maintains multiple simultaneous

links between various ports. It proficiently manages network traffic by reducing media sharing - traffic is contained to the segment for which it is destined, be it a server, power user or workgroup.

It is a cost-effective technique for increasing the overall network throughput and reducing congestion on a 10-Mbps network. Other than the addition of the switching hub, the Ethernet network remains the same the same network interface cards, the same client software, the same LAN cabling.

There are three basic types of switches on the market at this time. They all perform the same basic function of dividing a large network into smaller sub-networks, however the manner in which they work internally is different. The types are known as Store and Forward, Cut Through, and Hybrid. A description of each type is shown below:

A Store and Forward switch operates much as its name implies; first it stores each incoming frame in a buffer, checks it for errors, and if the frame is good it then forwards it to its destination port.

A Cut Through switch operates differently than a Store and Forward type. In a Cut Through switch, the switch begins forwarding the frame immediately upon recieving the Destination Address.

A Hybrid switch is an attempt to get the best of both Store and Forward switches and Cut Through switches. A Hybrid switch normally operates in Cut Through mode, but constantly monitors the rate at which invalid or damaged frames are forwarded.

Designing A Switched Ethernet Network

Designing a switched Ethernet network is actually a fairly straightforward process. The first step is to evaluate the traffic flow through you expect each user or group of users to generate.

Analysis of the network will most likely find that you have a large number of users who are not going to place a heavy load on the network, and a smaller number of users who will place a large load on the network. We now group the Undemanding Users together on a hub and connect each hub to a switch port. Our more demanding users will usually be either directly connected to the switch, or if they are on hubs, fewer of them will be sharing each switch port than on the Undemanding User portion.

One point which should be kept in mind regarding the design of a switched network is that traffic patterns vary by user and time. Therefore, just taking a " snapshot" of network usage patterns may lead to the wrong conclusions and result in a design, which is not optimal. It is always advisable to monitor usage patterns over a period of several days to a week to decide how to allocate network bandwidth optimally. Also, in almost all cases, a process of trial and error may be required to fully optimize the design.

· It is most important to get a switch that doesn't drop frames.

· Latency is a concern, but take it with a grain of salt. It will not make that much of a difference.

· Deciding between cut-through and store-and-forward depends on the application. Time-sensitive applications may need the former.

· Multimedia stations need dedicated switched ports.

· Most switch implementations consist of a switch with many stations (demand) and few servers (resources). It is best to keep a 1: 1 ratio between demand and resource. Or, as mentioned earlier, increase the number of access pipes to the resource. (i. e., multiple lines into one server)

· Baseline your network prior to installing switches to determine the percentage of bad frames that already exist on the network.

· RMON (Remote Monitor) capability embedded in switch ports is may be costly, but it may save time andmoneyin the long run.

· Certain switches support a flow control mechanism known as " back pressure." This spoofs collision detection circuitry into thinking there is a collision and subsequently shifting to a back-off algorithm. This throttles back the sending station from transmitting any further data until the back-off process is complete. Switches with this feature need to be placed into the network carefully.

What is 100baseT and Why is It Important?

100baseT, also known as Fast Ethernet, is simply a new version of Ethernet that runs at 100 million bits per second, which is ten times the speed of the existing Ethernet standard. 100baseT is becoming very popular because networks need more bandwidth due to more users and to demanding

applications like graphics and networked databases. In fact, for many applications, standard Ethernet is simply too slow. For this reason, most experts believe that 100baseT will eclipse Ethernet as the dominant standard for Local Area Networks (LANs) during the next few years.

A major advantage of all variants of 100baseT is software compatibility with standard Ethernet. This means that virtually all existing operating systems and application programs can take advantage of 100baseT capabilities without modification.

One way fast Ethernet helps network managers make incremental upgrades at relatively low cost is by supporting most wiring and cabling media. The 100-Mbit/s specification can run over the Category 3 and Category 5 wiring already in place. It also runs over fiber optic cabling already installed.

Fast Ethernet offers three media options: 100Base-T4 for half-duplex operation on four pairs of Category 3 UTP (unshielded twisted pair) or Category 5 UTP, 100Base-TX for half- or full-duplex operation on two pairs of data-grade Category 5 UTP or STP (shielded twisted pair), and 100Base-FX for half- or full-duplex transmission over fiber optic cable (the specification should be completed by year's end). As with other high-speed LAN technologies, fast Ethernet operates most efficiently on higher-grade media, such as Category 5 cabling or fiber.

For Category 3-based installations, the 100Base-T4 media option uses four pairs of Category 3 UTP cabling. Data is transmitted on three pairs of wires, utilizing standard 8B/6T coding, which allows a lower signal frequency and

decreases electromagnetic emissions. However, because the 100Base-T 4 standard uses the three pairs of wires for both transmission and reception, a 100Base-T4 network cannot accommodate full-duplex operation, which requires simultaneous dedication of wire pairs to transmission and reception.

Work is still in progress on 100Base-FX fast Ethernet over fiber, but trials show it to be stable and capable of sustained 100-Mbit/s throughput at distances over 100 meters. Essentially, as a second means of transmitting data over fiber, 100Base-FX will be an alternative to FDDI. Moreover, because it will support full-duplex operation, 100Base-FX has the potential to become a significant backbone technology.

100BASE-T Fast Ethernet represents the best choice for customers interested in high speed networking for many reasons.

There are 40 million 10 Mbps (Mega-bit per second) Ethernet users in the world today. 100BASE-T technology has evolved from this 10 Mbps world. By keeping the essential characteristics of the Ethernet technology (known as CSMA/CD) unchanged in the 100Mbit world, customers and installers can benefit from the body of Ethernet expertise developed over the years.

The Ethernet industry expects that 100BASE-T will offer ten times the performance for twice the price of 10BASE-T. This improvement is made possible by advances in integrated circuit chip technology. As chips get smaller, they run faster, use less energy and are cheaper to produce. Early Ethernet controllers were made in 1. 2 micron chips. State-of-the-art

technology uses 0. 45 micron chips. This represents an almost eight-fold reduction in chip size.

100BASE-T technology offers unparalleled ease of migration. You can decide how fast to upgrade, in what steps and stages, without massive " fork-lift" upgrades. Most 100BASE-T network cards will run as 10BASE-T and 100BASE-T cards. You will be able to buy cards now and run them at 10BASE-T speeds. Later when you are ready to upgrade to 100BASE-T you will not need to change your network cards.

100BASE-T is widely supported by many different companies. These include networking, systems, semiconductor, computer, integrator and research companies. Many of these companies have been supporting the industry effort through the Fast Ethernet Alliance. Wide support is essential for network users, ensuring a ready supply of interoperable products at competitive prices.

The transmission systems of the 100BASE-T standard have high data integrity. It was shown that if 100 million 100BASE-T networks were run at maximum speed it would take over a billion times the age of the universe before there would be an undetected error. These error rates are significantly better than for 10BASE-T, Token Ring and FDDI.

Recently, PC LAN adapter card manufacturers like 3Com and SMC have made very aggressive moves to further accelerate the adoption of 100baseT by pricing their 100baseTX products at only a slight premium compared to their standard Ethernet products. For example, a 3Com 100baseTX card is

priced at $149, compared to $129 for their Ethernet card. Because virtually all 100baseTX cards also support 10baseT, this means that customers are being encouraged to buy the 100baseT capability even if they don't need it today. In other words, you can buy the 100baseTX card today and use it on your existing 10baseT network; when you upgrade your network to 100baseTX, you won't have to throw away your adapter cards. By all accounts, this strategy has been very successful.

Gigabit Ethernet is an extension of the highly successful 10Mbps (10Base-T) Ethernet and 100Mbps (100Base-T) Fast Ethernet standards for network connectivity. IEEE has given approval to the Gigabit Ethernet project as the IEEE 802. 3z Task Force.

Gigabit Ethernet is fully compatible with the huge installed base of Ethernet and Fast Ethernet nodes. The original Ethernet specification was defined by the frame format and support for CSMA/CD (Carrier Sense Multiple Access with Collision Detection) protocol, full duplex, flow control, and management objects as defined by the IEEE 802. 3 standard. Gigabit Ethernet will employ all of these specifications.

In short, Gigabit Ethernet is the same Ethernet that managers already know and use, but 10 times faster than Fast Ethernet and 100 times faster than Ethernet. It also supports additional features that accommodate today's bandwidth-hungry applications and match the increasing power of the server and desktop.

To support increasing bandwidth needs, Gigabit Ethernet incorporates enhancements that enable fast optical fiber connections at the physical layer of the network. It provides a tenfold increase in MAC (Media Access Control) layer data rates to support video conferencing, complex imaging and other data-intensive applications.

Gigabit Ethernet compatibility with Ethernet preserves investments in administrator expertise and support staff training, while taking advantage of user familiarity. There is no need to purchase additional protocol stacks or invest in new middleware. Just as 100Mbps Fast Ethernet provided a low-cost, incremental migration from 10Mbps Ethernet, Gigabit Ethernet will provide the next logical migration to 1000Mbps bandwidth.

This section discusses the various topologies in which Gigabit Ethernet may be used. Gigabit Ethernet is essentially a " campus technology", that is , for use as a backbone in a campus-wide network. It will be used between routers, switches and hubs. It can also be used to connect servers, server farms (a number of server machines bundled together), and powerful workstations.

Essentially, four types of hardware are needed to upgrade an exiting Ethernet/Fast Ethernet network to Gigabit Ethernet :

· Gigabit Ethernet Network Interface Cards (NICs)

· Aggregating switches that connect a number of Fast Ethernet segments to Gigabit Ethernet

· Gigabit Ethernet repeaters (or Buffered Distributors)

The five most likely upgrade scenarios are given below :

1. Upgrading server-switch connections

Most networks have centralized file servers and compute servers A server gets requests from a large number of clients. Therefore, it needs more bandwidth. Connecting servers to switches with Gigabit Ethernet will help achieve high speed access to servers. . This is perhaps the simplest way of taking advantage of Gigabit Ethernet.

2. Upgrading switch-switch connections

Another simple upgrade involves upgrading links between Fast Ethernet switches to Gigabit Ethernet links between 100/1000 Mbps switches.

3. Upgrading a Fast Ethernet backbone

A Fast Ethernet backbone switch aggregates multiple 10/100 Mbps switches. It can be upgraded to a Gigabit Ethernet switch which supports multiple 100/1000 Mbps switches as well as routers and hubs which have Gigabit Ethernet interfaces. Once the backbone has been upgraded, high performance servers can be connected directly to the backbone. This will substantially increase throughput for applications which require high bandwidth.

4. Upgrading High Performance Workstations

As workstations get more and more powerful, higher bandwidth network connections are required for the workstations. Current high-end PCs have buses which can pump out more than 1000 Mbps. Gigabit Ethernet can be used to connect such high speed machines.

Gigabit Ethernet will be an ideal solution for many of the networking challenges confronting MIS departments today. With businesses implementing more powerful technologies like super-fast servers and data-intensive applications such as video streaming, videoconferencing, or high-speed file backups, the new Gigabit Ethernet standard will go a long way toward adding significant bandwidth at reasonable costs. The following explains some of the key advantages Gigabit Ethernet will provide.

Gigabit Ethernet will offer a dramatic increase (as much as a hundredfold) in pure bandwidth to help organizations meet the challenges of overburdened or growing network infrastructures. Gigabit throughput will greatly relieve pressures on LAN backbones while providing both the scalability and speed users need to run data-intensive applications productively. When gigabit data rates become available, firms will be able to greatly expedite large file transfers between servers and other devices.

Mirroring the price and performance benefits that Fast Ethernet brought to Ethernet networking, Gigabit Ethernet will offer ten times greater performance than today" s Fast Ethernet at two to three times the cost. The working groups are selecting technologies, such as the Fibre Channel physical layer for fiber, with these specific cost targets in mind.

Gigabit Ethernet will maintain the 802. 3 and Ethernet standard frame format, as well as 802. 3 managed object specifications. As a result, organizations can easily upgrade to gigabit speeds while preserving existing applications; operating systems; protocols such as IP, IPX, and AppleTalk; and network management platforms and tools.

Managing Gigabit Ethernet networks upgraded from Fast Ethernet backbones will be simple and easy because the new technology requires no learning curve or training for MIS staffs.

By offering backward compatibility with existing 10/100 Ethernet standards, Gigabit Ethernet will provide the same outstanding investment protection that Fast Ethernet offered. When upgrading to gigabit performance, companies will maintain existing wiring, operating systems, protocols, drivers, and desktop applications. No training is required for users or network managers, and network management tools and applications will remain intact. Administrators will be able to keep existing tried-and-tested hardware, software, and management practices while providing-with minimal risk and cost-the networking functionality and performance their organizations require.

Gigabit Ethernet is the third generation Ethernet technology offering a speed of 1000 Mbps. It is fully compatible with existing Ethernets, and promises to offer seamless migration to higher speeds. Existing networks will be able to upgrade their performance without having to change existing wiring, protocols or applications. Gigabit Ethernet is expected to give existing high speed technologies such as ATM and FDDI a run for their money. The IEEE is

working on a standard for Gigabit Ethernet, which is expected to be out by the beginning of 1998. A standard for using Gigabit Ethernet on twisted pair cable is expected by 1999.